THE GARDEN OF EDEN PERIOD FOR DEEP STRUCTURE AND SEMANTICS

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1 Syntax and Semantics before *Aspects*

At the time of *Aspects* (Chomsky, 1965), the expression "syntax-semantics interface" was still decades away from its first appearance, but questions about the potential relation between syntax and semantics had figured in Chomsky's writings from the start. Chomsky clearly considered semantics important in principle, while expressing considerable skepticism about the prospects for developing a scientific theory of meaning. Between *Syntactic Structures* and *Aspects*, work by Katz & Fodor and Katz & Postal influenced Chomsky to become cautiously optimistic about the possibility of a semantic component for generative grammar. The theory presented in *Aspects* was characterized by an elegant architecture in which deep structure formed the input to semantic interpretation, transformations mapped deep structure to surface structure, and that in turn formed the input to phonological interpretation. The brief period when the *Aspects* theory held sway is what I like to call the "Garden of Eden period". I conclude with a brief review of some of the causes of the "expulsion from the Garden" that soon followed[1].

1.1 Before *Syntactic Structures*

In the century before *Syntactic Structures,* linguistics became at least in part a science, but semantics was not part of that development. Linguistics began to emerge as a science in the nineteenth century with the German *Junggrammatiker's* breakthrough discoveries about sound changes and the evolutionary history of the Indo-European languages. Darwin in his *Origin of Species* "said that linguistics, as practiced by the leading exponents of comparative Indo-European philology, offers the paradigm of scientific method" (Harris and Taylor, 1997, p.187).

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[1] I say nothing in this note about the explosion of work in semantics and the syntax-semantics interface that began soon after *Aspects*, or about semantics in other linguistic traditions or in philosophy and logic. See Partee 2011, 2014; all of these issues will be discussed in Partee in preparation.

And in both Europe and the U.S., there was a self-conscious drive to view linguistics as a science in the 1930's; linguistics was part of the Vienna Circle's "unified science" movement, with the semiotician Charles Morris as one of its leaders.

As for semantics, there was a mixture of negative attitudes and neglect in American linguistics in the 20th century. There had been rather little semantics in early American anthropological linguistics, since linguistic fieldwork generally had to start with phonetics, then phonology, then morphology, then perhaps a little syntax; any work on semantics was limited to dictionary-making and semantic features for the structural analysis of kinship terms and other such lexical domains. The behaviorists viewed meaning as an unobservable aspect of language, not fit for scientific study, and that had some influence on the Bloomfieldians. Quine had strong philosophical skepticism about the concept of meaning, and his and Goodman's influence on Chomsky is acknowledged in the preface to *Syntactic Structures*.

Chomsky has frequently expressed ambivalence about semantics as a science and about the relation between syntax and semantics. This is evident even before *Syntactic Structures* in *The Logical Structure of Linguistic Theory* (*LSLT*; Chomsky, 1975b). In *LSLT*, Chomsky writes in the first chapter:

> I will merely emphasize again that the "legitimacy of semantics" (whatever that might mean) has never, to my knowledge, been challenged, nor has there ever been any question of the importance of incorporating a study of reference, meaning, language use, and related topics within a full theory of language that will deal, in particular, with the highly significant relations between formal structure and semantic interpretation. The appeal to meaning must be clearly distinguished from the study of meaning. The latter enterprise is unquestionably central to the general theory of language, and a major goal of the *SS-LSLT* approach is to advance it by showing how a sufficiently rich theory of linguistic form can provide structural descriptions that provide the basis for the fruitful investigation of semantic questions. (Chomsky, 1975b, 21)

But also in *LSLT* he writes "Part of the difficulty with the theory of meaning is that "meaning" tends to be used as a catch-all term to include every aspect of language that we know very little about" (Chomsky, 1975b, fn 21, p. 97).

So before *Syntactic Structures* (Chomsky, 1957) there was no syntax-semantics interface to think about in linguistics.

1.2 In *Syntactic Structures*: Chomsky on Semantics in 1957

Syntactic Structures contains clear evidence of Chomsky's ambivalence about semantics, with assertions of its importance along with insights into challenges facing any attempt to construct a systematic theory relating syntax and semantics.

He spends many pages arguing that semantic notions are of no use in constructing a grammar, and arguing that intuitions of grammaticalness are distinct from intuitions of meaningfulness. "Grammar is best formulated as a self-contained study independent of semantics. In particular, the notion of grammaticalness cannot be identified with meaningfulness." (p.106)

But at the same time he holds that one test of a good syntax is that it should provide a good basis for a good semantics (if we had any idea how to study semantics). "In other words, we should like the syntactic framework of the language that is isolated and exhibited by the grammar to be able to support semantic description, and we shall naturally rate more highly a theory of formal structure that leads to grammars that meet this requirement more fully." (p.102)

And he argues that transformational grammar is a positive step in that direction, since it uncovers differences at the "transformational level" that are obscured in the output. "The general problem of analyzing the process of "understanding" is thus reduced, in a sense, to the problem of explaining how kernel sentences are understood, these being considered the basic 'content elements' from which the usual, more complex sentences of real life are formed by transformational development." (p.92).

In *Syntactic Structures*, he illustrates this point with an example of ambiguity that cannot be captured at the level of phrase structure: he argues for a transformational derivation of the ambiguous (1a) from two different kernel sentences, (1b) and (1c) (pp.88-89). He takes this as an example of a property that grammars should have: a correspondence between constructional ambiguity and "real cases of ambiguity" (p.86).

(1) a.   the shooting of the hunters
    b.   The hunters shoot.
    c.   They shoot the hunters.

But Chomsky also notes that transformations sometimes change meaning. "… we can describe circumstances in which a 'quantificational' sentence such as [(2a)] may be true, while the corresponding passive [(2b)] is false, under the normal interpretation of these sentences—e.g., if one person in the room knows only French and German, and another only Spanish and Italian. This indicates that not even the weakest semantic relation (factual equivalence) holds in general between active and passive." (pp. 100–101)

(2) a.   Everyone in this room speaks two languages.
    b.   Two languages are spoken by everyone in this room.

In later years, those judgments about (2) came to be questioned; it has been claimed either that both (2a) and (2b) are ambiguous, or that (2a) is unambiguous but the passive (2b) is ambiguous. Chomsky himself has a long footnote[2] in *Aspects* noting that it is possible that both sentences are ambiguous, but with different readings preferred for (2a) and (2b).

His general worries about the study of meaning are clearly expressed in *Syntactic Structures*:

> In proposing that syntactic structure can provide a certain insight into problems of meaning and understanding we have entered onto dangerous ground. There is no aspect of linguistic study more subject to confusion and more in need of clear and careful formulation than that which deals with the points of connection between syntax and semantics. The real question that should be asked is: "How are the syntactic devices available in a given language put to work in the actual use of this language?" (p. 93)

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[2] This is footnote 9 to Chapter 3 of *Aspects*, pp. 224-225. We discuss it in Section 2.2 below.

I would sum up Chomsky's attitude toward semantics in 1957 approximately as follows: Semantics is in principle an important part of linguistic theory; a theory of syntax should probably be judged in part by the support it provides for semantic interpretation; but semantics itself is a subject not so far amenable to scientific investigation, and it is misguided to appeal to meaning in the explanation of syntactic phenomena. The seriousness with which Chomsky took semantics may be seen in the final paragraph of *Syntactic Structures*, which ends with a cautious call for the study of syntax and semantics and their interface:

> More generally, it appears that the notion of "understanding a sentence" must be partially analyzed in grammatical terms. To understand a sentence it is necessary (though not, of course, sufficient) to reconstruct its representation on each level, including the transformational level where the kernel sentences underlying a given sentence can be thought of, in a sense, as the 'elementary content elements' out of which this sentence is constructed. In other words, one result of the formal study of grammatical structure is that a syntactic framework is brought to light which can support semantic analysis. Description of meaning can profitably refer to this underlying syntactic framework, although systematic semantic considerations are apparently not helpful in determining it in the first place. The notion of "structural meaning" as opposed to "lexical meaning", however, appears to be quite suspect, and it is questionable that the grammatical devices available in language are used consistently enough so that meaning can be assigned to them directly. Nevertheless, we do find many important correlations, quite naturally, between syntactic structure and meaning; or, to put it differently, we find that grammatical devices are used quite systematically. These correlations could form part of the subject matter for a more general theory of language concerned with syntax and semantics and their points of connection. (pp. 107–108)

1.3 Between *Syntactic Structures* and *Aspects*: Katz, Fodor, Postal

Jerrold Katz and Jerry Fodor were the first to work on adding a semantic component to generative grammar (Fodor, 1961, Katz, 1961, Katz and Fodor, 1962, 1963). They were concerned with compositionality, which they generally called the Projection Problem: how to get the meaning of a sentence from meanings of its parts. Hodges (1998) identifies their 1963 paper as the first use of the term "compositionality". "As a rule, the meaning of a word is a compositional function of the meanings of its parts, and we would like to be able to capture this compositionality" (p. 501 in the version reprinted in (Fodor and Katz, 1964)). "…the fact that a speaker can understand any sentence must mean that the way he understands sentences he has never previously encountered is compositional: on the basis of his knowledge of the grammatical properties and the meanings of the morphemes of the language, the rules the speaker knows enable him to determine the meaning of a novel sentence in terms of the manner in which the parts of the sentence are composed to form the whole." (p. 482 in the version reprinted in Fodor and Katz 1964).

Since at that time, "Negation" and "Question Formation" were tranformations of affirmative and declarative sentences, transformations could clearly change meanings, and meaning depended on the entire transformational history. Katz and Fodor's semantic Projection rules applied to T-markers, which were extensions of the phrase structure P-markers.

Katz and Fodor took compositionality seriously at the outset of their work on semantics; theirs is probably the first theory of the "syntax-semantics interface". Their semantic tools were quite primitive, however, with semantic representations consisting of sets of "semantic features", undoubtedly influenced by feature theories of phonology and componential analysis of kinship terms, etc., and quite unsuited for anything beyond the decomposition of one-place predicates[3]. The idea that truth conditions might be relevant to semantics did not penetrate linguistics until after 1970.

In a theoretically important move related to the problem of compositionality, Katz & Postal (1964) made the innovation of putting such morphemes as Neg and a question morpheme Q into underlying structure, arguing that there was independent syntactic motivation for doing so. Then meaning could be determined on the basis of underlying structure alone. The Katz-Postal hypothesis was an interesting and provocative claim, and even without any "real semantics" at the foundation, it led to interesting debates about apparent counterexamples, which we return to in Section 3. And it became one of the pillars of the *Aspects* theory.

2 Semantics in *Aspects*

Among the innovations in Chomsky's *Aspects,* the two that are central to the development of semantics are the syntactic innovations that led to "deep structure", and the incorporation of the Katz-Postal hypothesis that transformations preserve meaning. Chomsky's adoption of Katz and Postal's conception of semantics is explicit in Footnote 10 to Chapter 1, Methodological Preliminaries: "Aside from terminology, I follow here the exposition in Katz and Postal (1964). In particular, I shall assume throughout that the semantic component is essentially as they describe it …" (p.198)

2.1 Deep Structure and the Katz-Postal Hypothesis

Where "generalized transformations" had previously been responsible for assembling kernel sentences into multiclausal structures, in *Aspects* the base phrase structure component is responsible for generating deep structures that assemble all the parts in their underlying forms. That structure together with the Katz-Postal hypothesis made it possible for Chomsky in *Aspects* to propose that deep structure is the input to semantics.

> Thus the syntactic component consists of a base that generates deep structures and a transformational part that maps them into surface structures. The deep structure of a sentence is submitted to the semantic component for semantic interpretation, and its surface structure enters the phonological component and undergoes phonetic interpretation. The final effect of a grammar, then, is to relate a semantic interpretation to a phonetic interpretation—that is, to state how a sentence is interpreted. This relation is mediated by the syntactic component of the grammar, which constitutes its sole "creative" part. (Chomsky 1965, pp. 135–136)

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[3] Reactions from philosophers, most famously Lewis' (1970) critique of "Markerese", are discussed in Partee, 2011, Partee, In press.

2.2 Chomsky on Semantics in *Aspects*

The basic architecture of the theory presented in *Aspects* was elegant and attractive. And probably not coincidentally, some of Chomsky's most positive statements about semantics occur in this period. The following paragraph in Chapter 3 not only underscores the idea of deep structure as the input to semantics, but asserts that such an idea had "motivated the theory of transformational grammar since its inception."

> Thus when we define "deep structures" as "structures generated by the base component," we are, in effect, assuming that the semantic interpretation of a sentence depends only on its lexical items and the grammatical functions and relations represented in the underlying structures in which they appear[4]. This is the basic idea that has motivated the theory of transformational grammar since its inception (cf. note 33, Chapter 2). Its first relatively clear formulation is in Katz and Fodor (1963), and an improved version is given in Katz and Postal (1964), in terms of the modification of syntactic theory proposed there and briefly discussed earlier. The formulation just suggested [with deep structures generated by the base component] sharpens this idea still further. In fact, it permits a further simplification of the theory of semantic interpretation presented in Katz and Postal (1964), since Transformation-markers and generalized transformations, as well as "projection rules" to deal with them, need no longer be considered at all. This formulation seems to be a natural extension and summary of the developments of the past few years that have just been summarized.
>   Notice that in this view one major function of the transformational rules is to convert an abstract deep structure that expresses the content of a sentence into a fairly concrete surface structure that indicates its form. (p.136)

And a little later in the same chapter we find an optimistic statement about compositionality and the possibility that the compositional interpretation rules might be universal:

> In a somewhat similar way, the projection rules of the semantic component operate on the deep structure generated by the base, assigning a semantic interpretation (a "reading") to each constituent, on the basis of the readings assigned to its parts (ultimately, the intrinsic semantic properties of the formatives) and the categories and grammatical relations represented in the deep structure. (See Katz and Fodor, 1963; Katz and Postal, 1964; and other papers by Katz listed in the bibliography.) To the extent that grammatical categories and relations can be described in language-independent terms, one may hope to find universal projection rules, which need not, therefore, be stated as part of a specific grammar. (p. 144)

Looking back at these endorsements of the goal of developing a compositional semantics, I can see why I was so surprised by Chomsky's later negative reactions to early attempts to combine Montague's compositional formal semantics with Chomsky's transformational syntax (Chomsky, 1975a). And Chomsky's remarks later in Chapter 3 about semantic puzzles not

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[4] At this point in the text there appears Footnote 9, which contains a discussion of the problem posed by sentences with quantifiers like (2a-b) above, and to which we return at the end of this subsection.

solved by available means could be seen as potential encouragement of the direction taken soon after by generative semanticists, who may also have been surprised at his reaction to their work.

> Finally, it is important to be aware of the many other problems that face a theory of semantic interpretation of the kind referred to in the preceding discussion. It is clear, as Katz and Fodor have emphasized, that the meaning of a sentence is based on the meaning of its elementary parts and the manner of their combination. It is also clear that the manner of combination provided by the surface (immediate constituent) structure is in general almost totally irrelevant to semantic interpretation, whereas the grammatical relations expressed in the abstract deep structure are, in many cases, just those that determine the meaning of the sentence. Cf., for example, Chapter 1, §4, and Ch 2, § 2.2. However, there are cases that suggest the need for an even more abstract notion of grammatical function and grammatical relation than any that has been developed so far, in any systematic way[5]. Consider, for example, these sentence pairs:

> > (109)   (i) John strikes me as pompous - I regard John as pompous
> > (ii) I liked the play - the play pleased me
> > (iii) John bought the book from Bill - Bill sold the book to John
> > (iv) John struck Bill - Bill received a blow at the hands of John

> Clearly, there is a meaning relation, approaching a variety of paraphrase, in these cases. It is not expressible in transformational terms, as is possible, for example, in these cases:

> > (110)   (i) John is easy for us to please - it is easy for us to please John

> … Consequently, it seems that beyond the notions of surface structure (such as "grammatical subject") and deep structure (such as "logical subject"), there is some still more abstract notion of "semantic function" still unexplained. Various formal devices for expressing these facts suggest themselves, but the general problem seems to me non-trivial. (pp. 161-2)

We noted at the beginning of this subsection that when Chomsky first states his assumption that semantic interpretation depends only on underlying structure, he adds a footnote about the problems of some sentences with quantifiers. In particular, he is concerned there with the same active-passive pair (2a-b) that he used in *Syntactic Structures* as evidence that transformations sometimes change meaning. In *Aspects,* the discussion is much more nuanced, with the possibility that pragmatic and other factors could explain a difference in preferred interpretation, and perhaps the semantics could correctly assign both scope interpretations to both sentences.

> Footnote 9: As it stands, this claim seems to me somewhat too strong, though it is true in one important sense of semantic interpretation. For example, it seems clear that the order of "quantifiers" in surface structures sometimes plays a role in semantic interpretation.

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[5] The examples in (109) suggest a need for a more abstract grammatical structure only if sentences which are (near-) semantic paraphrases must have a common (or very similar) deep structure. But compositionality does not impose such a requirement: with a richer semantics, sentences with quite different syntactic structures can be assigned the same or similar meanings.

Thus for many speakers – in particular, for me – the sentences "everyone in this room knows at least two languages" and "at least two languages are known by everyone in this room" are not synonymous. Still, we might maintain that in such examples both interpretations are latent (as would be indicated by the identity of the deep structures of the two sentences in all respects relevant to semantic interpretation), and that the reason for the opposing interpretations is an extraneous factor – an overriding consideration involving order of quantifiers in surface structures – that filters out certain latent interpretations provided by the deep structures. In support of this view, it may be pointed out that other sentences that derive from these (e.g., "there are two languages that everyone in the room knows") may switch interpretations, indicating that these interpretations must have been latent all along. There are other examples that suggest something similar. … (pp. 224-5)

We will return to quantifiers in Section 3; in 1965, linguists had not yet discovered the most serious problems they pose for the Katz-Postal hypothesis.

2.3 The "Standard Theory" and the Garden of Eden Period

During the brief period when *Aspects* held sway, and its theory had been dubbed by Chomsky the "Standard theory", there was a rosy optimism that the form of syntactic theory was more or less understood and linguists could concentrate on figuring out the "substantive universals". Quite a few dissertations were written about the grammar of one language or another, all with deep structures similar to what Chomsky proposed for English in *Aspects*, and differing only in what transformations applied to make those languages look different from English on the surface. This was also the period when the "Universal Base Hypothesis", the conjecture that the grammars of all natural languages have the same base rules, was developed independently by McCawley, Lakoff, and Bach; see brief discussions in (Partee et al., 1990, p.556) and (Newmeyer, 1980, pp. 148-50), and more in (Peters and Ritchie, 1973).

In that period, roughly the mid-60's, before the linguistic wars broke out in full force, generative grammarians generally believed the Katz and Postal hypothesis. The idea that meaning was determined at this "deep" level was undoubtedly part of the appeal of the notion of deep structure beyond linguistics (cf. Leonard Bernstein's Norton Lectures (Bernstein, 1976)) and probably contributed to the aura surrounding the notion of "language as a window on the mind."

So around 1965, there was very widespread optimism about the Katz-Postal hypothesis that semantic interpretation is determined by deep structure, and the syntax-semantics interface was believed to be relatively straightforward (even without having any very sophisticated ideas about the nature of semantics.)

3 The "Discovery" of Quantifiers and Expulsion from the Garden

What happened to upset that lovely view? Although of course there were multiple factors, I think it's fair to focus on one salient issue: linguists discovered quantifiers (Bach, 1968, Karttunen, 1968, Karttunen, 1969, Lakoff, 1968, McCawley, 1971).

It is a surprising historical accident that the behavior of quantifiers with respect to transformational rules familiar from *Syntactic Structures* and *Aspects* was not really noticed until the Katz-Postal hypothesis had for most linguists reached the status of a necessary condition on writing rules.

Transformations that preserved meaning (more or less) when applied to names clearly did not when applied to some quantifiers. Clear examples come from "Equi-NP Deletion", the transformation that applied to (3a) to give (3b).

(3) a. John wants John to win.
    b. John wants to win.

When the identical NPs are names, the transformation is meaning-preserving[6]. But if applied to sentences with quantifiers, it would have the unwanted result of deriving (4b) from (4a).

(4) a. Everyone wants everyone to win.
    b. Everyone wants to win.

Similar problems arise for the then-assumed Reflexivization transformation: should (5b) be derived from (5a)? And likewise for the "Conjunction-Reduction" transformation, which would transform (6a) into the non-synonymous (6b).

(5) a. Every candidate voted for every candidate.
    b. Every candidate voted for himself.
(6) a. Every number is even or every number is odd.
    b. Every number is even or odd.

These problems struck at the heart of the Katz-Postal hypothesis and hence at the basic architecture of the *Aspects* theory. There were two classes of responses by linguists, the Generative Semantics response and the Interpretive Semantics response. The ensuing linguistic wars have been well documented (Harris, 1993, Huck and Goldsmith, 1995, Newmeyer, 1980, Seuren, 1998). Here I want to note how each side could reasonably claim to be following a research program with its roots in *Aspects*.

The Generative semantics response (Lakoff, Ross, McCawley, Postal, early Dowty, Larry Horn, sometimes Bach) maintained the principle that deep structure should be the input to semantics, and argued (along the lines of Chomsky's footnote 9 in Chapter 3 of *Aspects*, but going much farther) that it needs to be deeper, more abstract, more like "logical form" (first-

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[6] Even with names, later work brought subtle semantic differences to light, e.g. differences between identity *de re* and identity *de se* (Chierchia, 1989, Lewis, 1979). We ignore those differences here; the semantic difference between (4a) and (4b) is orders of magnitude greater and was universally appreciated as soon as it was noticed.

order-logic). They were trying to preserve the kind of elegant relation between the deepest level of structure and semantic interpretation that Chomsky had espoused, following Katz and Postal, in *Aspects*. Their adherence to that goal led to many divergences from the syntactic part of the *Aspects* theory; what they held onto and pushed as far as they could was the idea that the underlying level should optimally support semantic interpretation[7].

The Interpretive semantics response (Chomsky, 1971, Jackendoff, 1972) was to make sure that syntax remained 'independently motivated', as Chomsky had insisted in all of his work, and to take examples like those above as evidence that the Katz-Postal hypothesis was mistaken. Chomsky and Jackendoff were ready to give up the principle that an ambiguous sentence should always have two different deep structures, since there did not seem then (nor does there seem now) to be any independent syntactic evidence for syntactic ambiguity for a semantically ambiguous sentence like (7).

(7) Every student answered one question correctly.

The interpretive semanticists preserved more of the syntactic theory of *Aspects*, and gave up the idea of doing all semantic interpretation at the level of deep structure, proposing that different semantic modules may work at different levels, and that quantifier scope and anaphoric relations might be determined at surface structure. The resulting syntax-semantics relationship was architecturally more complex and seemed *ad hoc* to critics.

This note ends here, with the linguistic wars going on in full force, but the story doesn't.

Although the linguistic wars are now "history", the issues that were fought over are by no means settled even now. Many very real problems were unearthed in those early post-*Aspects* years. And how best to account for the scope possibilities of quantifiers and other operators has remained one of the most challenging and interesting ones. By the end of the 1980's there were already at least half a dozen theoretically quite dissimilar proposals for treating the relationship between syntactic structures and the possible semantic scopes of quantifiers in English (see (Partee, 2014) for thumbnail sketches and references), and there are many more now. Argumentation has in the meantime been enriched in many ways -- by a broader range of work on universals and typology, by psycholinguistic studies of syntactic and semantic processing, and by a wealth of studies on the cross-linguistics acquisition of quantificational structures by children.

The *Aspects* model did not survive – no theory does – but the elegance of its architecture of syntax, semantics and phonology sometimes evoke dreams of a lost paradise; a nice dream while it lasted. Actuality, fortunately, has been at least as interesting, and the many directions that syntax and semantics have gone in since *Aspects*, and the many discoveries that have been made, have made the syntax-semantics interface one of the most richly flourishing subfields of linguistics.

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[7] The generative semanticists generally held to the same questionable principle discussed in footnote 5 above, that semantic relatedness should be reflected in syntactic relatedness at the most abstract or underlying level.

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